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THE *What's New* MAGAZINE

New!
Minto's Unique
STEAMLESS
"STEAM" CAR

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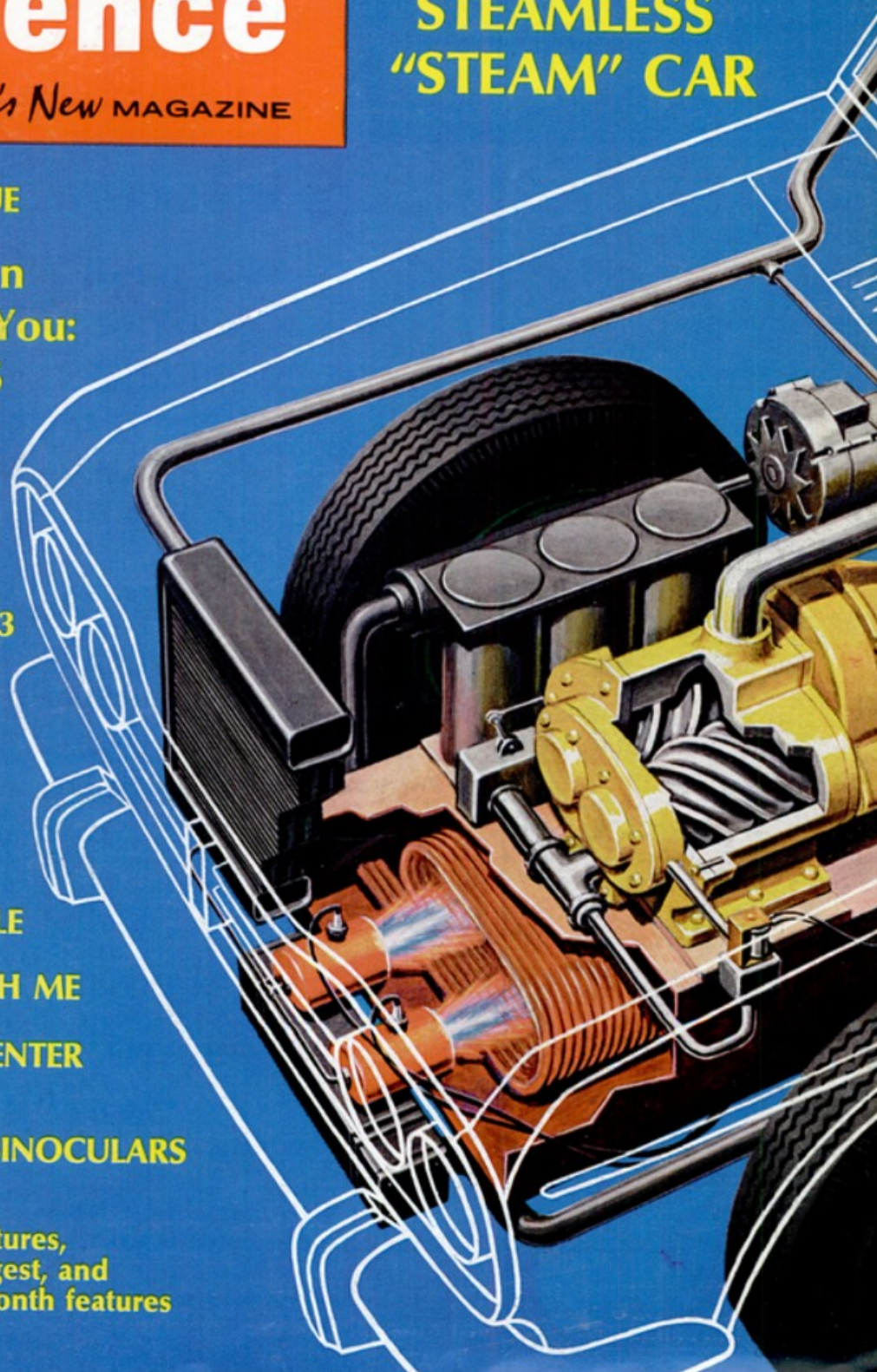
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New: Minto's Unique Steamless "Steam" Car

This antipollution car uses an external-combustion engine with a refrigerant for a working fluid. Soon it will go into production—in Japan

By E. F. LINDSLEY
ILLUSTRATION BY RAY PLOCH

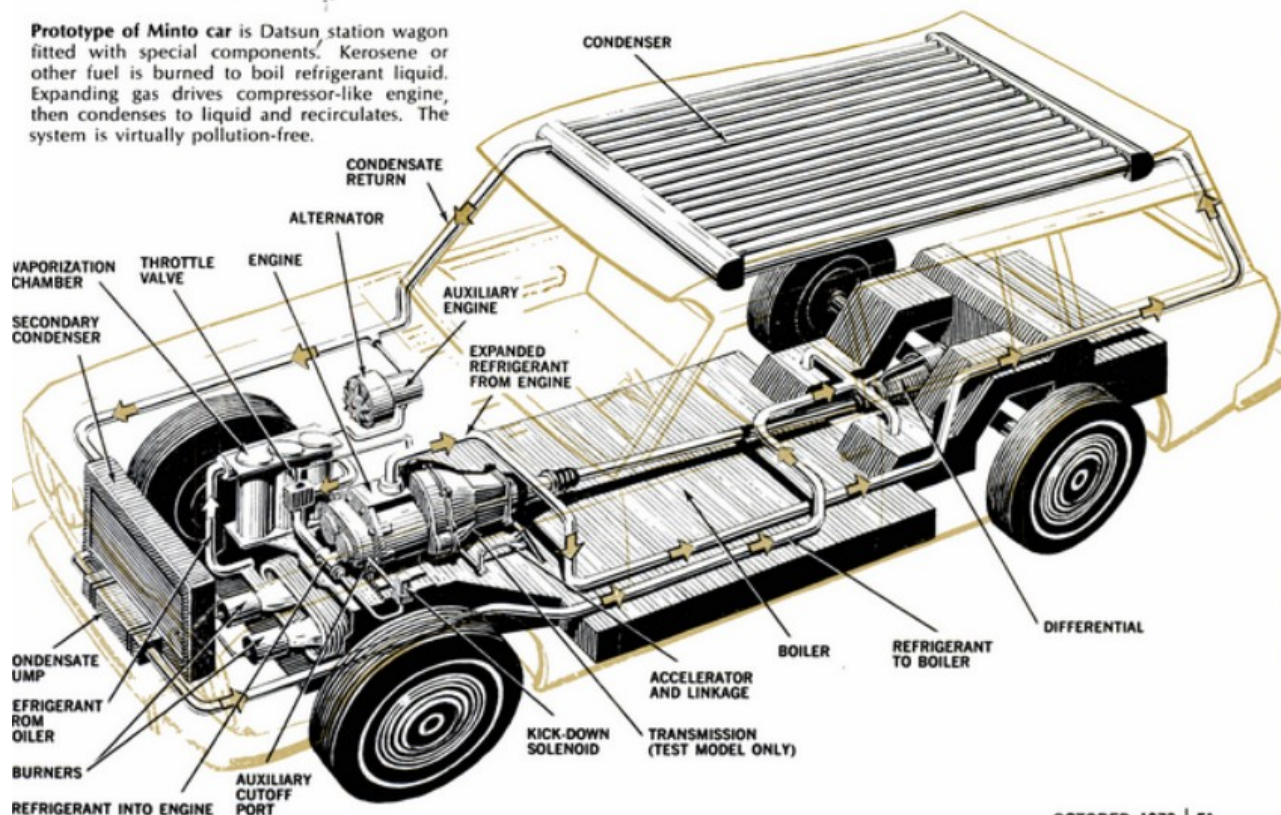
Just about now, if you happen to be a reader living in the Southeast, you may see a Datsun station wagon pull up to a stoplight: It will probably catch your attention because you won't hear the engine idling as the driver waits for the light. You'll also notice that the little wagon moves out briskly and almost silently—the only sound will be a soft whine. And you won't see any exhaust. You will be looking at the prototype of one of the first really pollution-free cars ever built—one that Datsun's maker has agreed to produce by 1972!

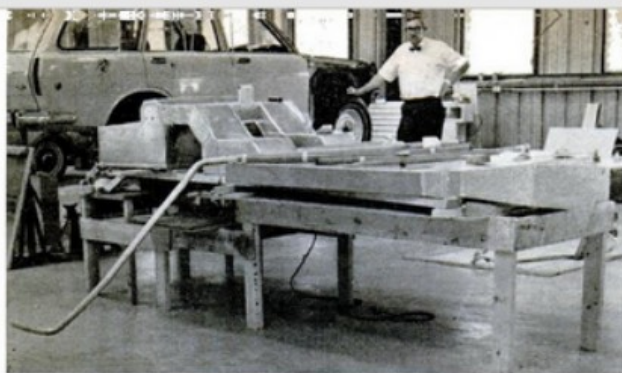
Under the hood will be a small, and unique, engine driven by expanding fluorocarbon. The heat to expand

the R-113 fluorocarbon refrigerant will come from burning hydrocarbon fuel, probably kerosene (although almost anything will do). According to Wallace L. Minto, developer and President of Kinetics, Inc. in Sarasota, Fla., the secret is no secret—external combustion, properly engineered, of course, produces only carbon dioxide and water. Both are normal components in our atmosphere. The Datsun will emit no semiscavenged lead, no measurable oxides of nitrogen, and virtually no carbon monoxide.

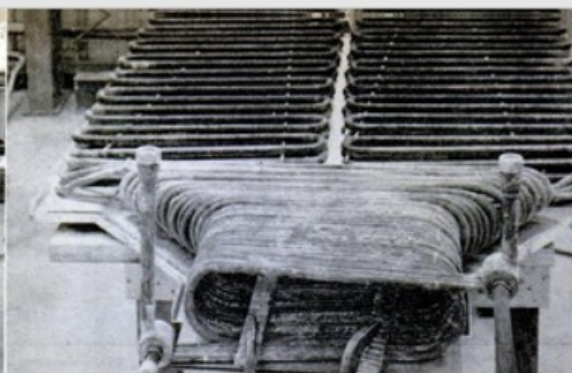
Steam-engine fans, aware of the merits of external combustion and the simplified mechanics and drive train made possible by expanding a nonburning gas, have long

Prototype of Minto car is Datsun station wagon fitted with special components. Kerosene or other fuel is burned to boil refrigerant liquid. Expanding gas drives compressor-like engine, then condenses to liquid and recirculates. The system is virtually pollution-free.





Datsun station wagon being fitted with refrigerant engine will receive the boiler housing seen in foreground. Housing looks over-size; actually, it fits precisely under the wagon.



Refrigerant boiler, made of coiled steel tubing, was set up as shown for testing. One like it will slip inside aluminum housing under the car. The burners fire into the front opening.

foreseen just such a car. But practical problems in applying steam have stalled, so far, even the biggest names. Some of the problems with steam are:

- Freezing in cold climates
- High pressures and superheat needed for efficiency
- Bulky size of boilers and piping
- Hazard from hot water and steam in an accident
- Large water volume, wasteful of heat energy on cool-down.

Wallace Minto thinks he has the answer in Ucon R-113 fluorocarbon, Union Carbide's name for a common, non-combustible refrigerant. (Du Pont's name for it is Freon.) R-113 vaporizes at 117 degrees F, a fact of overwhelming importance to safety. Moreover, R-113 has the thermodynamic characteristics needed; it doesn't freeze; it liquefies readily within a condenser of practical physical size; and, because of its high density, it can be handled in small pipes and valves. All of these qualities make for lighter, stronger, and less-expensive parts, which can be fitted into an automobile economically and practically.

A thorough engineer. "The numbers have to check out" is one of Minto's favorite expressions when he talks of the complex laws of gas expansion, entropy, and the work available from an engine. To prove his "numbers," Minto first built a test model using the unlikely combination of a VW minibus and a genuine Stanley Steamer engine. Burning propane as a convenient heat source, he cooked his batch of R-113 in a tubular boiler, fed it through the old Stanley engine very successfully, and condensed it in some cobbled-up cooling coils from conventional refrigeration equipment. This was the classic Rankine cycle, using the working fluid—in this case R-113 instead of steam—over and over. Unlike the dramatic bursts of exhaust steam from old-time locomotives, the Rankine cycle chills the engine exhaust back into liquid, collects the

liquid, and re-injects it into the boiler for use again.

Unfortunately, the Stanley engine was a reciprocating-piston type, and efficiency was not very high. What was needed was a rotary engine with parts that kept turning without changing direction every 180 degrees. A turbine could be used, but turbines lack low-speed torque, work better when wound up tight at constant speed, and take some pretty hefty gear reductions to get down to the working range for a car axle. Minto sought a positive displacement power plant, one that started with high torque from a dead stall—as did the old piston steam engines—and that would eliminate clutches, gear shifts, torque converters, and the other heavy, expensive accouterments of ordinary drive trains.

Vane-type engines, various exotic rotaries, and a host of others were checked out before coming up with two rotors, fluted somewhat like sections of a twist drill with the flutes intermeshing. Initially, the physical diameters and the pitch diameters of both rotors were the same. It worked, but not as efficiently as Minto thought it could.

Compressor in reverse. Eventually, he found what he was looking for in existing air compressors. Here were two fluted rotors, but the flutes were different. Although the physical diameters were the same, the pitch diameters differed. One rotor had six flutes, the other had four. They ran together, but the four-lobed male rotor turned $1\frac{1}{2}$ times the speed of the six-fluted female. The device compressed air efficiently and simply, with only two moving parts.

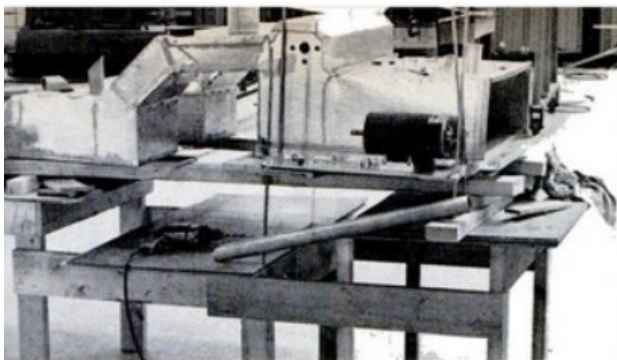
Minto's engine reverses the air compressor. Fluorocarbon R-113 gas, laced with a fluorosilicone lubricant, enters the space between the rotors, is trapped as the flutes turn and cut off the inlet ports, and expands with a wedging action between the flutes to rotate the engine. The expansion ratio is about 8:1. Starting from zero rotation, as with the car at a stop sign, simple expansion against the positive-displacement rotors starts the car rolling. At higher speeds, the velocity of the gas impinging on the rotors adds significantly to the power.

Mount engines anywhere. The engines, actually Swedish-built Sullair compressors (or, optionally, Japanese Myakawas of almost identical design) are powerful. Size for size, or weight for weight, they are much more powerful than electric motors. The present engines are not especially designed for weight saving, yet they are light compared with equivalent piston engines. Now weighing 55 pounds in cast iron, they will be made of aluminum. They can be mounted almost anywhere in the vehicle and run in any position; straight up, down, or sideways. Minto envisions final application with the engine mounted directly on the rear axle.

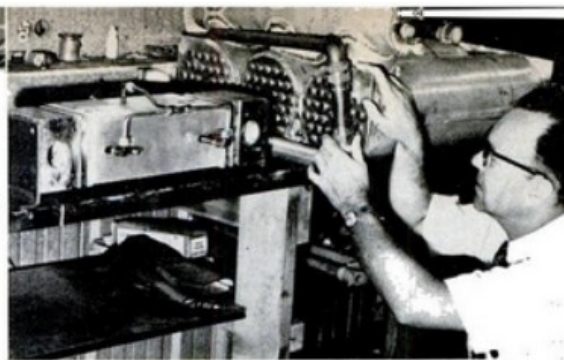
Since rotor speed may range from zero rpm up to 8,000-10,000 rpm, or even higher, the present axle ratios in the experimental Datsun are not adequate. For test purposes



Inventor Wallace L. Minto points out rooftop condenser for ancient Stanley Steamer engine, driven by refrigerant fluid, that powers this VW minibus. Vehicle was a test bed to prove theory.



Boiler circulating pump seen at left rear of boiler housing keeps refrigerant liquid moving in boiler to prevent hot spots. Dynamometer and boiler test equipment are set up in background.



Heat recovery and vaporizer unit is examined by Chief Engineer Leonard Keller. Refrigerant flashes into gas and is reheated by burner exhaust here. Box on left is the boiler feed pump.

he uses a conventional gear box behind the engine. Future engines will be direct reversing, but right now he uses the gears to back up and help test engine speed vs. car speeds.

The hardware needed to run Minto's Datsun is necessarily "prototype." After all, adapting an external combustion engine to a vehicle designed for internal combustion can be expected to offer problems of size and shape. Later, a car designed around the fluorocarbon engine will make things easier. So will production components that really fit, rather than hand-fabricated assemblies. Even so, Minto has the following basic parts in workable form:

- **Boiler**, consisting of a shallow pancake of steel tubing coiled to fit in an insulated, double-walled, aluminum housing snugged up under the car.

- **Burners** (two) of conventional industrial oil-burner pattern, but highly modified for extremely clean, efficient burning.

- **Engine**—70 hp at 5,000 rpm, mounted conventionally. High horsepower is not needed because of the excellent torque characteristics.

- **Condensers**, consisting of a primary, flat, thin, multi-tube panel mounted in the car roof, and a secondary unit mounted in the usual radiator location.

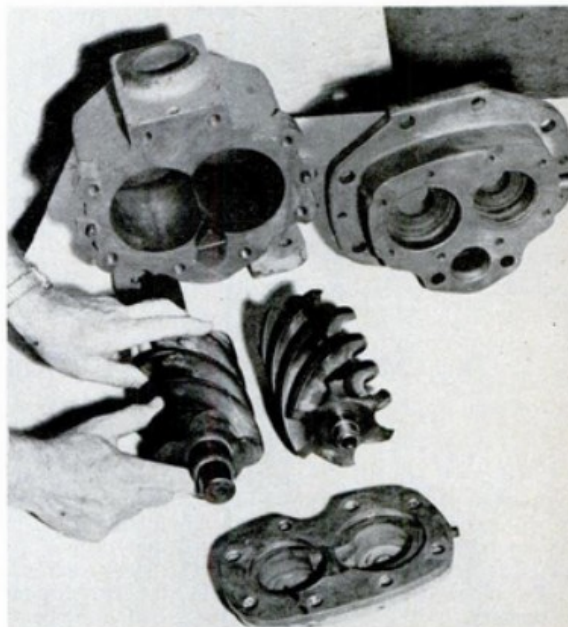
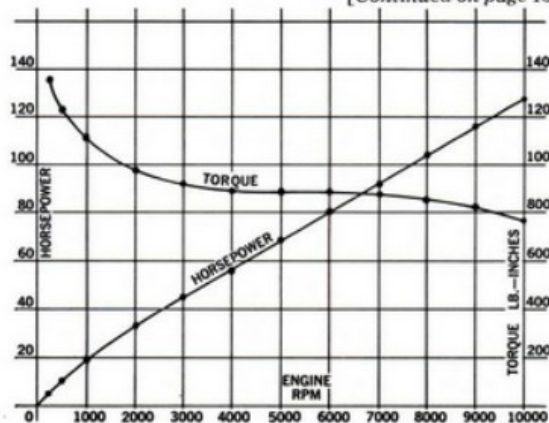
- **Vaporization chamber and heat recovery economizer**, to flash the heated liquid to gas and recover part of the burner exhaust heat.

- **Throttle**, small auxiliary engine to drive alternator, boiler feed pump, fuel tank, and fuel pump.

Following the working cycle of the engine from the point where the liquid R-113 is cold in the boiler, here is what you'd see:

How the power flows. After burner ignition by the usual spark arc, the R-113 warms to a working level in about ten seconds. A circulating pump keeps the fluid

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Gases enter engine through valve plate at front and wedge the rotors to develop high-speed rotation. Male rotor (piston) on left delivers 80 percent of power, turns 1½ times faster.



Rooftop condenser is one of several Minto car components production would improve in shape and other ways. Hand-built test unit shown here is made of aluminum tubing finned inside and out.

Power curves show maximum-load pickup ability when engine starts from dead stall, tremendous torque backup as load pulls engine down to stall.

Minto's Steamless "Steam" Car

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moving within the boiler coils so no hot spots or gas pockets form. Transformation from liquid to gas occurs as the fluorocarbon is valved automatically into the vaporization chamber, where recovered heat from the burner exhaust heats it further. This, among other things, is an economy measure. The maximum temperature of the exhaust from the car's burner is 450 degrees—this only on hard acceleration. Automatic sensing of boiler pressure controls fuel flow to the burner at a ratio of about 10 or 12:1.

Fluorocarbon gas at 350–375 degrees F under pressure up to 250 psi is throttled to the engine in response to the driver's accelerator pedal. The engine turns and the car moves. For additional torque at highway speeds, a kick-down switch pops open a solenoid valve to introduce gas later in the rotation cycle. In steam-engine parlance, this changes the cutoff point. In automobile terms, you can really peel rubber.

After leaving the engine, the R-113 gas passes rearward and upward to the condenser plastered against the roof top. Doubting engineers claim the condenser size will be overwhelming. Minto, using internally and externally finned Alcoa aluminum extruded tubing, says it's no problem. The semi-condensed gas leaves the rooftop unit in a "fog" state, partially liquid, and enters the secondary condenser, which provides final cooling and acts as a storage tank. This secondary condenser is not really needed except under full load conditions.

A simple condensate pump, powered by a small amount of gas acting against a piston with differential diameters, serves to force the liquid back into the boiler to repeat the cycle.

Same fuel consumption. All of this is accomplished with a fuel consumption about the same as the internal combustion engine in the Datsun. Kerosene is denser than gasoline, and has more BTUs per gallon. With minor changes to the burner, very cheap grades of fuel oil could be burned.

The car now under construction will be about 10 percent heavier than the original Datsun because it uses hand-built parts plus components adapted from other applications. By fabricating parts especially for the car, eliminating the present transmission and drive line, and taking full advantage of the engine placement possibilities, the ultimate car weight will be the same or less than that of the present internal-combustion model.

Two other happy results are expected. One is an on-the-market car

price 10 to 20 percent lower than with the present engine. The other bonus is better handling because of a lower center of gravity. This stems from the location of the boiler and its contained fluid under the floor. Moreover, hard braking at speeds over 45 mph builds up a reverse pumping action that slows down the vehicle promptly.

What about safety? Boiler explosions have haunted steam engines from the beginning. Wallace Minto has several answers to this objection. He points out that every car with air conditioning has Freon working at several hundred psi and temperatures of 200–250 degrees F. This seems to pose no special hazard, even in an accident. Of course, his engine would have 80 to 85 pounds of R-113 in the system. On the other hand, the boiler is of the liquid-tube type, and a failure is likely to produce a small leak within the double-walled protective housing. This is equivalent to a small valve leak in a tire as compared to a blowout—quite unlike the bursting of a fire-tube boiler shell. Accidents in the test program have shown that hot fluorocarbon blasting into the air travels about an inch and almost instantly cools to outside boiling point, 117 degrees F—hardly a scalding temperature. And, of course, the kerosene fuel is less of a fire hazard.

Is Minto's engine just another dream or is it really headed for production? As we went to press, Minto announced that he had signed a multi-million-dollar contract with Nissan of Tokyo, cailing for mass production of the engine and its use in Datsun automobiles made in Japan. The inventor estimated that more than 100 Minto-engine-equipped Datsuns would be manufactured in 1972, after he has delivered first a demonstrator model and then a production prototype. After that, he believes, production will be greatly increased.

Minto also hopes to provide a higher-powered version of his engine to a Japanese manufacturer of boats, tractors, and construction equipment.

Nissan will have exclusive rights to manufacture the auto engine in Asia, but the way will be left open for Minto to make similar arrangements with European or American car makers. So far, at least, no American firm has shown signs of interest.

Living in a tightly packed country where pollution is an even more acute problem than here, the Japanese seem to be a bit more open to new concepts. Ironically, the world's first production car to meet proposed American federal pollution standards may be made in Japan.

Bike with a Car Battery

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tensioning spring over the head of any of five machine screws set in the right-hand side plate. The spring upper end fits onto a 1/4" threaded rod, stiffened by nuts on either side of the spring arm. You can swing the motor up off the tire by attaching the lower end of the spring to a 1/4" bolt through the side of the bike's frame just forward of the battery.

The pulley is fixed on the motor shaft with a pin supplied with the motor. I contoured the pulley to match tire shape and wrapped plastic tape around the contact area of the pulley to increase friction.

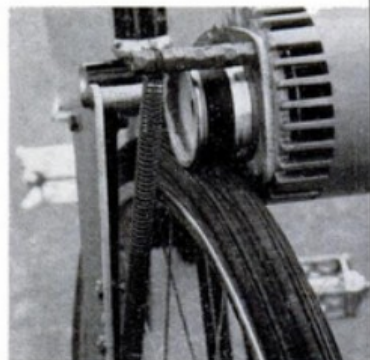
Battery mounting. The battery rests on two 5" lengths of 3/4"-by-3/4" angle iron 1/8" thick. They're bolted to the frame through a 1"-wide tab at center of each bracket. The tabs are made by hacksawing two cuts 1/2" apart, then bending the metal between the cuts until tab angle matches frame angle.

Two 6-32 threaded rods, laid between the battery's ends and the brackets, support side straps of 1/2"-by-3/8" aluminum. Four 1/4"-diameter spacers of aluminum tubing on the ends of the rods prevent sideways battery movement.

Drive motor. The Minn-Kota motor has three speeds, selected by switching taps on its series field windings with a rotary wafer switch. Using the pulley described on a 26" wheel, level-ground speeds are four, eight, and 13 mph. Speed falls off on modest hills, and you have to pedal a little on steep ones.

I found that current drain averages about 15 amps. So a 60 amp-hour, 12-volt battery provides four hours—about 40 miles—of riding. To reduce rolling resistance, I keep my tires inflated to between 60 and 70 pounds.

One reminder: Police may challenge you when you take to the road on your motorized bike!



Friction drive uses a screen-door spring to hold the motor pulley against a tire.